TABLE 1.—*Mean maximum, minimum, and range of temperature at the Weather Bureau and Forest Park observatories, St. Louis, Mo.*

	January.		February.		March.		April.		May.		June.	
	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.
Maximum	42.8	41.9	43.9	43.8	45.9	44.8	67.4	66.7	72.8	72.1	84.1	82.7
Minimum	30.5	28.0	27.9	25.0	32.0	30.4	50.0	45.6	54.3	48.8	67.3	63.6
Range	12.3	13.9	16.0	18.8	13.9	14.4	17.4	21.1	18.5	23.3	16.8	19.1
Diff. in min., W. B.—F. P.	2.5		2.9		1.6		4.4		5.5		3.7	

	July.		August.		September.		October.		November.		December.		Five-year averages.	
	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.	W. B.	F. P.
Maximum	83.8	82.3	83.4	82.8	84.3	84.3	67.2	67.3	47.8	47.8	50.8	50.8	64.1	63.5
Minimum	66.0	60.5	66.2	61.4	63.8	54.8	47.9	42.1	35.1	32.9	34.7	33.2	47.5	42.9
Range	17.8	21.8	17.2	21.4	20.5	29.5	19.3	25.2	12.7	14.9	16.1	17.6	16.6	20.6
Diff. in min., W. B.—F. P.	5.5		4.8		9.0		5.8		2.2		1.5		4.6	

gales caused by northwest lows are few in number, and they appear to be of three types: The low which steadily increases in energy as it drifts eastward; the low immediately succeeded by a great cold wave; and the low which at first travels far southeastward, and then suddenly recurves northeastward. The violent gales from west lows are even fewer than those from the northwest; but a suggestion has already been hinted at elsewhere in this paper regarding this class of areas. The southwest low so frequently shows such energy from its apparent inception that no doubt exists as to its ultimate destructive character; but if in a seemingly weak area two or more foci appear, or should there be a secondary development in the southern part of the system, or on or near the United States Atlantic coast, usually in the vicinity of New Jersey or Connecticut, then a storm of great violence almost invariably ensues. There are not many Atlantic lows, as will be seen by referring to the table; nearly all, however, bring a gale to the Maritime Provinces, although the violent gales caused by them are few in number, doubtless owing to their general course being far to the southward of Nova Scotia.

The erratic developments herein considered must not be confounded with the erratic change of the course of a low from the normal to the abnormal, which from time to time is observed. These apparent peculiar or backward movements of depressions are so rare that they hardly enter into the consideration; however, it would be very interesting to have the opinion of others on the causes of these sporadic movements, especially as there are instances on record where, owing to such conditions, the gale which had seemingly subsided has again set in with greater violence than before.

ABSTRACT OF A COMPARISON OF THE MINIMUM TEMPERATURES RECORDED AT THE UNITED STATES WEATHER BUREAU AND THE FOREST PARK METEOROLOGICAL OBSERVATORIES, ST. LOUIS, MO., FOR THE YEAR 1891.[1]

By W. H. HAMMON and F. W. DUENCKEL.

Forest Park, St. Louis, Mo., is a tract of ground about 1 mile wide from north to south and 2 miles long from east to west, its eastern boundary being about 4 miles west of the Mississippi River. About midway between the park and the river, at Thirty-sixth street, is a slight elevation, and east of this, in Mill Creek Valley and along the banks of the Mississippi, the principal manufactories are located.

The principal railroads from the west enter the city by way of the valley of the River des Pères and Mill Creek Valley. Along these railroads are several manufactories, but the nearest of any importance is 1½ miles south of the southeast corner of the park.

From this it seems that the park is quite well removed from the smoke and other conditions peculiar to large cities, except when east winds, which are infrequent, prevail.

The observatory is located on a slight knoll about half a mile from the east end of the park and midway between the northern and southern boundaries. About 100 yards to the north and 30 feet lower than the observatory is a valley through which flows a small stream, while to the southwest is quite a heavy forest growth extending back from the observatory to the top of a slight ridge. In other directions are open lawns interspersed with small groves of trees.

The thermometer shelter, which is of the Weather Bureau pattern, is located about 96 feet east of the observatory building, 10 feet above the sod, and 75 feet from the nearest trees.

The anemometer is exposed 8 feet above the roof of the observatory and 58 feet above ground. It is on a general level with the tops of surrounding trees.

The observatory of the United States Weather Bureau is located in the Government building at Eighth and Olive streets, a little more than half a mile from the river. It is surrounded on all sides by chimneys belching forth smoke from bituminous coal, which is almost the exclusive fuel of the city. The building covers an entire block 300 feet square, and is arranged about a court which is open to the lower floor.

The thermometer shelter is located 10 feet above the copper roof of this building, and 110 feet above the level of the street.

On the center of the south front of the building is a tower 200 feet high, on the top of which the anemometer is exposed far above the tops of surrounding structures.

Table 1 shows the monthly means of the daily maximum, minimum, and range of temperature during the year 1891, at both the Weather Bureau and the Forest Park stations. It also shows the differences between the monthly mean minimum temperatures at the two stations, and the annual averages for the above data for the five years 1891–1895, inclusive.

The noteworthy feature of this table is the difference in the monthly mean minimum temperatures at the two stations, the Forest Park minimums averaging from 9.0° lower in September to 1.5° lower in December. The extreme differences have ranged from 20° lower to 2° higher.

In order to study these remarkable differences, tables were prepared in which were entered the minimum temperature recorded at 8 a. m., the cloudiness at 8. a. m. and the previous 8 p. m., and the average wind velocity during the night. Curves were also drawn showing the relation between the cloudiness, the velocity of the wind, and the minimum temperature differences at the two stations. In general it was found that as the cloudiness increased the wind velocity also increased, and the differences between the minimum temperatures decreased. It was also found that both the cloudiness and the velocity of the wind exerted an influence upon the minimum temperature differences.

In the study of these observations it was found that during the clear skies of September the maximum differences were recorded, while during the cloudiest months (March and December), the differences were least, and that they remained small during all the winter months. There were, however, marked exceptions to this rule, as for instance in January, 1892, when the difference exceeded 20° on three successive days. During this period there was a heavy covering of snow on the ground at the park and for a portion of the time there was a little snow in the city, but it was soon covered with soot and quickly disappeared.

A special study was made of the minimum temperature differences on all the days when snow was on the ground at the

[1] Compiled by W. H. Hammon, Forecast Official United States Weather Bureau, and F. W. Duenckel, of the Forest Park Meteorological Observatory; read before the St. Louis Academy of Science, March 2, 1896, and now first published.

park, and it was found that the average difference almost equalled that for September.

The following quotation is from an article "On the influence of the accumulations of snow on climate," by Alexander Woeikoff, Quarterly Journal of the Royal Meteorological Society, Vol. XI, 1885, p. 299.

A covering of snow on the ground acts, firstly, as a bad conductor, rendering the interchange of temperatures between the surface of the ground and the lower stratum of air much slower than when the snow is absent.

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We see that as a covering of snow protects the upper parts of the ground from radiation and makes the conduction of heat much slower than it would otherwise be, it thus tends to raise the temperature of the soil; but it must have a contrary influence on the lowest stratum of the air, as the snow protects it from the conduction of heat from the ground, an action which, as this is generally warmer in winter, must make the lowest stratum of the air colder. This it undoubtedly does; but in this respect another quality of the snow is even more important, namely, that it is a good radiator of heat.

The influence of smoke from the factories of the city upon the minimum temperature differences has also been studied. It was invariably noticed that on the day preceding a night with an unusually large minimum temperature difference, the wind which had been from the north, became calm. On the eastern horizon the smoke of the city appeared very dense and extended upward to an unusual height, while at the park the sky was very clear. On the following morning the wind changed to the south and gradually increased in velocity.

If two or more consecutive days showed a remarkable difference in the minimum temperatures at our two stations, as was the case in January, 1892, it was because the air remained calm and clear at the park, while the smoke appeared to be heaped up over the city. Invariably at such times the barometer indicated the presence of the crest of an area of high pressure, and its passage accounted for the change in the direction of the wind.

It thus appears that the principal cause of the difference in the minimum temperature readings at the Forest Park and the Weather Bureau observatories is the accumulation of smoke over the city, especially on nights when the sky is clear and the wind light. These conditions favor a rapid radiation of heat from the ground at the park, while the smoke over the city acts like a cloud covering and materially retards radiation.

It is well to notice here the advantages that arise from selecting the northwesterly sections of a city for residence purposes and southeasterly sections for manufacturing purposes.

STUDIES ON THE STATICS AND KINEMATICS OF THE ATMOSPHERE IN THE UNITED STATES.

By Prof. FRANK H. BIGELOW.

I. A NEW BAROMETRIC SYSTEM FOR THE UNITED STATES, CANADA, AND THE WEST INDIES.

On January 1, 1902, at the 8 a. m. observation, seventy-fifth meridian time, a new system for the reduction of the station barometric pressures to the sea-level plane, was put in operation for the United States, Canada, and the West Indies. The daily weather maps used in forecasting the intensity and the path of storms, and the other allied phenomena, are therefore constructed upon a basis differing from any hitherto used. Students who consult the published weather maps should remember that the series terminating with the above date is not comparable with the others following it, the difference at some stations on the Rocky Mountain Plateau for certain seasons of the year amounting to several tenths of an inch of pressure by the mercurial barometer. The problem of reducing the pressures observed at stations located on the Rocky Mountain Plateau to sea level has always been recognized as one of unusual scientific difficulty, and it has been under discussion in the Washington Office at intervals ever since the establishment of the Government service. So far as can be judged at the present writing the success of the new system is assured, and if this favorable opinion is confirmed by continued use, it will mark the termination of thirty years' effort to solve this question in a practical form. The other plateau districts of the world, Mexico, South America, especially Argentina, south Africa, Australia, and southern Asia, will doubtless profit by the experience of the United States Weather Bureau, on consulting the solution adopted for the United States, Canada, and the West Indies.

Prof. R. F. Stupart, Director of the Canadian Meteorological Office, has courteously cooperated by supplying the necessary data for the Canadian stations, since the common interests of both countries require the adoption of the same methods of barometric reductions. There is no task properly belonging to the Weather Bureau upon which more time and labor has been expended than upon this problem, and the present discussion is the sixth well defined attempt to reach a satisfactory conclusion. The importance of putting the barometric pressures on the elevated plateau, covering one third of the territory for which the official forecasts are made, on a satisfactory scientific basis, fully justifies this work, because it is of primary importance not to attribute to weather conditions any pressure changes that are in reality due to the method of reduction to the plane of reference.

PRELIMINARY REMARKS.

The eastern and central portions of the United States and Canada are generally at levels less than 1,000 feet above the sea, and also the Pacific coast is at low level, so that for these districts the barometric reduction offers no difficulty. Between these, throughout the Rocky Mountain region, there is a rough country where the stations are at different elevations up to 7,000 feet, where the surface temperature conditions range enormously, say from $-40°$ F. to $+60°$ F. on a single map in extreme cases, where the prevailing winds from the Pacific Ocean produce one type of weather on the western slopes of the mountains and another on the eastern, to say nothing of the effect of great arid districts between them, and where the configuration of the mountain valleys, in which many of the stations are located, relative to the neighboring ranges rising up to 12,000 or 14,000 feet in some cases, causes various local peculiarities in the behavior of the barometer.

A description of the construction of our new station pressure normals is properly a preliminary to the solution of the plateau problem. In the years between 1871–1880, while the barometric network was being extended over the plateau districts, many of the elevated stations were at the Army posts where no measurement of the altitude had been made, except by the barometer. We now know that several of these early elevations were seriously in error, say from 10 feet up to 200 feet, and as a change of 10 feet in altitude corresponds approximately to 0.010 inch pressure, the irregularities on the sea-level plane arising from this source alone were not inconsiderable. The gradual extension of the various surveys by the Government over the plateau, together with the railroad levels executed and revised by the different companies, have gradually built up a system of check levels at intersecting points, with accurate differential levels between them, so that now the absolute elevations of the several stations have been determined with much accuracy. An adjustment of these levels was made by Prof. Cleveland Abbe in 1871–72; the work was then taken up by the Geological Survey, and the latest results of these surveys are given in Gannett's Dictionary of Altitudes, edition of 1900. The Weather Bureau was supplied with the corrected altitudes before the publication of this report by the Geological Sur-